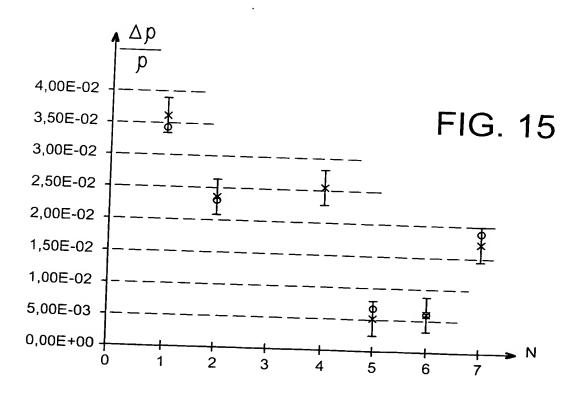


FIG. 8



## PRELIMINARY CALIBRATIONS

#### Step 1

calibrate the position of the two infrared assemblies of the apparatus to determine the significant dimension of the object

#### Step 2

calibrate the position of the irradiation support of the apparatus to determine the intensity of the photon beam attenuated by passing through the object

## Step 3

calibrate the measurement of the source - detector assembly of the apparatus to determine the intensity of the photon beam attenuated by passing through the object.

FIGURE 9A

# ACTUAL DETERMINATION OF THE RELATIVE VARIATION OF THE DENSITY

Step 4

determine the significant dimension of the object to be tested

Step 5

transport the object to the irradiation support

Step 6

adjust the position of the object by adjusting the position of the irradiation support with respect to a source and an associated detector

Step 7

determine the attenuated intensity of the photon beam transmitted through the object

Step 8

acquisition, processing and analysis of the spectrum obtained

Step 9

determine the relative variation of the density of the object with respect to the density of one or several objects with standard density

Step 10

return transport of the object to its location on the turntable.

FIGURE 9B

manual input of input parameters

sequence of automated operations:

- a) move the base along the Z direction as far as the Zmeasure position
- b) angular displacement of the turntable to bring object edim into its initial measurement position
- c) displacement of the first infrared assembly along the Y direction as far as its start position Y(1)
- d) displacement of the first infrared assembly along the Y direction by increments of INT, and simultaneous determination of the infrared response RI(n) of the object edim, corresponding to each position Y(n), for n=1,...,N
- e) calculate the optimum infrared response RIOPT  $\frac{RI_{M\!M\!X}-RI_{M\!D\!N}}{2}$
- f) calculate the optimum position YOPT of the first infrared assembly with respect to the second infrared assembly and the optimum distance d between the two infrared assemblies

Step 2 manual input of input parameters sequence of automated operations: a) measure the significant dimension xemas of the object with standard density b) angular displacement of the turntable to bring the standard density object emas into an intermediate position in which it is gripped by the gripping arm c) position the object emas on the irradiation support d) actual adjustment of the position of the irradiation support with respect to the source - detector assembly: d-1) progressive displacement of the irradiation support along the Z direction between the predetermined positions Z(1) and Z(N) d-2) for each position Z(i), irradiation of the object emas by the photon beam M times, and obtain attenuated intensity values I(i,j) i=1, ..., N = number of positions Z(i) between Z(1) and Z(N)j=1, ..., M = number of irradiations for each position Z(i) d-3) calculate the optimum position ZOPT of the irradiation support from the positions Z(i) and attenuated intensities I(i,j) e) return transport of the object emas on the turntable.

- a) measure the photon intensity lemas attenuated by passing through a standard density object emas used as a reference
- b) calculate the mass attenuation coefficient μm of the standard density object using the following relation:

$$\rho_{emas} = -\frac{1}{\mu_{m} x_{emas}} L_{n} \frac{I_{emas}}{I_{o}}$$

FIGURE 12

# manual input of input parameters

sequence of automated operations:

- a) displacement of the base along the Z direction as far as the Zmeasure position
- b) displacement of the first infrared assembly along the Y direction, as far as the position Ymeasure = YOPT + (xedim – xedimAVE)
- c) measurement repeated P times of the infrared response RI(p) p = 1, ..., P of N standard dimension objects edim(n), n=1, ..., N leading to a set of values RI(n,p),
- d) actual calculation of the significant dimension x of the object 100
- d-1) calculate the average RledimAVE of P infrared responses of each of said objects edim(n) for which the significant dimensions xedim(n) are known, then calculate the coefficients A0, A1, A2, A3, A4 using the following relation xedim(n) = A4.(RledimAVE(n))4 = A3.(RledimAVE(n))3 = A2.(RledimAVE(n))2 + A1.(RledimAVE(n))1 + A0
- d-2) measure the infrared response RI(q),  $q=1,\ldots,Q$  of the object 100, then calculate the average of RI(q) values and calculate the significant dimension x of the object 100 using the relation x=A4.(RI)4+A3.(RI)3+A2.(RI)2=A1.(RI)1+A0

FIGURE 13

automated calculation of the relative variation  $\frac{\Delta \rho}{\rho}$  of the density of the object 100 with respect to the density of one or several standard density object(s) emas using the following relation:

$$\frac{\Delta \rho}{\rho} = \frac{x_{\text{emas}}}{x} \left[ 1 - \frac{L_n \frac{1}{I_{\text{emas}}}}{\mu_m \rho_{\text{emas}} x_{\text{emas}}} \right]$$

FIGURE 14